the production 24 months later. The reason for this is not known, but is apparently due to some building up of surplus soluble plant food in dry years. Likewise, this is the only eastern area where the April to June rainfall just before harvest has any measurable relation to the yield.

In district 7 the relation of all rainfall periods to yield is positive, whether to a long period of 24 months or a short period of 2 months, and also whether the period chosen is 2 or 3 years or 2 months prior to harvest. This is true of no other area. Likewise, the October–December and the January–March rainfall periods show some measurable influence which, as a rule, is not detectable in most areas. The August–October 3-month period shows the highest relation, +0.536. This estimate is improved by using the rainfall for 12 months prior to the previous August. These two factors together give +0.817. A fairly good estimate in this area can be given on September 15, 9 months before harvest, by employing the July–September rainfall. Then on January 15 this can be improved by using the October–December rainfall as an X_2 factor, and some further reductions in the error can be made on June 15 by using as an X_3 factor the March–May rainfall. This district, like district 5, shows a tendency for the errors of estimate to be plus 1 year and minus the following year.

In district 8 the same type of relationships are found as in district 5, but the correlations are not as high. The fall rainfall has a direct relation to yield, but rainfall prior to the previous harvest tends to show an inverse relation. Combinations of the fall rainfall into two or more factors give the best single or multiple relationships. These estimates can usually be improved by using the rainfall for either the 6-month or 12-month period before the previous crop. The best single factor is the August–October rainfall which has a relation of +0.694 with yield per acre. The earliest estimate in this area is in July, when one can use the January–June previous rainfall which has an inverse relation to yield, the same as in district 5.

In district 9 two conflicting relationships are present. Apparently in a series of dry years the previous fall rainfall has a direct relation, and in a series of wet years the relation is inverse. This cannot be shown statistically as yet. Errors of estimate in this area are greater than in any other district and predictions appear to be of little value. The best single relation is with the rainfall for 12 months prior to the previous harvest.

OTHER FACTORS AFFECTING YIELDS

Research studies have been conducted in an attempt to reduce the errors in judging the yield of grain. The influence of the subsoil moisture has been checked by using the accumulation of rainfall for 1 to 3 years before the dominant period. As was shown in districts 3, 5, 6, and 8 this relation is inverse to the current yield; and in districts 1, 4, and 7 it is direct.

The theory that the spring rainfall must be forecast before one can improve the estimates has been checked. To date all that can be said is that with the exception of district 7 spring rainfall tends to increase the errors as often as it reduces them. On the other hand, it is common knowledge that spring rains are essential to the crop. In most districts, however, there is some direct relation between fall and spring rainfall. This inner relationship of the two periods might explain the lack of the need for using the spring rainfall. Further studies will no doubt make it possible to improve the estimates by using spring rainfall.

The concept that a large crop is followed by a small one has been tested for all districts, and such a relation was found in districts 5, 7, and 8 to some extent. Apparently, this is important where wheat occupies the larger percentage of the cultivated area. There appear to be possibilities in such studies if they could be made by type-of-farming areas.

The relation of temperature to yield has been checked to some extent, and apparently accounts for some of the greatest errors in years of below-normal rainfall. A below-normal rainfall, with an above-normal temperature in November and December, tends to give the same yield as above-normal rainfall and normal temperature. This accounts in a large measure for the 1914 wheat crop, which was about twice as large as the fall rainfall and acreage would indicate. The standard error of estimate of the relationships given vary from 2.5 to 3.5 bushels per acre in the acres sown. These errors are reduced but little when more than two factors have been used.

LONGER TIME ESTIMATES

If possible, it is desirable to estimate the supply far enough ahead for it to be of some value in adjusting winter wheat production. From the discussion already given it is seen that a preliminary estimate can be made in most areas 1 or 2 months before seeding; and a much better estimate can be made by the time the crop goes into the dormant period, i. e., November or December. Estimates before seeding must for the most part be based on cumulative rainfall for a 12-month period prior to the previous harvest. In the eastern third of the State, the estimates are an indication of the direction of variation from the average yield, and are of a practical value when one considers the advantages in having some idea so far in advance of harvest. Since 1920 there have been only 3 years of large errors in district 3, and only 2 years of large errors in district 6. The error in the other years was negligible for long-time production planning. Since a high percent of the United States winter wheat crop is produced under conditions similar to those in the different sections of Kansas, there appears to be a possibility of using weather records to indicate desirable adjustments in wheat production.

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